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Is essential tremor a risk factor for carpal tunnel syndrome? A prospective study excluding the most common comorbid conditions

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ABSTRACT

Aims: Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy of the upper extremity, resulting from compression of the median nerve. Tremor, a rhythmic and involuntary movement of any part of the body, is the most common movement disorder, affecting millions of people worldwide. There is limited research on the coexistence of CTS and ET (essential tremor).

Methods: This prospective study included patients aged 18-65 who presented to the neurology outpatient clinic and were diagnosed with ET. Participants supplied informed consent, a sociodemographic form, and the Fahn-Tolosa-Marin Clinical Tremor Rating Scale (FTM TRS). Patients were evaluated for the presence and severity of CTS with electromyography (EMG). The EMG data were categorized as normal, mild, moderate, and severe CTS.

Results: In the study, the average age of the 50 ET patients was 56.0 (35.0-64.0) years. The gender distribution comprised 22 (44.0%) males and 28 (56.0%) females. The following tremor locations were reported: 41 (82.0%) in both upper extremities, 3 (6.0%) in the right upper extremity, 2 (4.0%) in the left upper extremity, 1 (2.0%) in both upper extremities, head tremor, and voice, and 3 (6.0%) in both upper extremities and head tremor. A high prevalence of CTS was detected in ET patients (46%). Additionally, a positive correlation was found between CTS in ET patients, long disease duration, and female gender. No significant relationship was found between FTM TRS Part A, Part B, Part C, total scores, and median sensory and motor nerve amplitude and velocity values in ETS patients.

Conclusion: CTS is more common in patients with ET. This suggests that ET may be a risk factor for CTS, independent of other factors. Early diagnosis and treatment of CTS in patients with ET is important to improve their quality of life.

Keywords: Essential tremor, carpal tunnel syndrome, Fahn-Tolosa-Marin clinical tremor rating scale.

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy of the upper extremity, resulting from compression of the median nerve.[1] The prevalence in the general population is between 4-5%.[2] It is known that individuals aged 40-60 years and women are at a higher risk for developing CTS.[2] Symptoms such as numbness, tingling, burning, and pain in the hand can lead to significant functional impairment of the affected hand.[3,4] Diagnosis of CTS is made through clinical and physical examination findings, in addition to electrodiagnostic tests.[2,3]

While CTS is an idiopathic condition, it has been associated with various other diseases.[5] It is known that prolonged wrist extension and flexion, as well as exposure to vibration, are risk factors for CTS.[2,5] Mechanical, traumatic hand movements are one of the risk factors for CTS.[2,4] The prevalence of CTS is 15 times higher in jobs involving high-force, high-repetitive, and low-force, low-repetitive tasks, supporting vibration, and repetitive movements as risk factors.[6]

Tremor, defined as a rhythmic and involuntary movement of any part of the body, is the most common movement disorder, affecting millions of people worldwide.[7] Essential tremor (ET) and Parkinson's disease (PD) are the two most common tremor disorders in adults.[8] While ET is characterized by the presence of action tremor, PD is defined by resting tremor,

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though it is well known that both disorders can include both types of tremor and share other overlapping clinical features.[9]

The association between tremors in PD and CTS has been studied, and differing opinions among experts have been held on whether tremors are a risk factor for CTS.[4,6,10,11] In contrast, there is limited literature on the coexistence of CTS with the more common ET.[8] Furthermore, the existing studies on ET and CTS often do not adequately represent ET in terms of age and the severity of the tremor.[12,13]

Considering the negative impacts of ET and CTS on quality of life and daily activities, even when occurring independently, determining the influence of ET on the commonly encountered CTS should be regarded as a research priority in clinical studies.[14,15]

METHODS

This prospective study included patients aged 18-65 who presented to the neurology outpatient clinic and were diagnosed with ET between August 1, 2023, and August 1, 2024. Ethical approval for this study was obtained from the Kastamonu University Clinical Researches Ethics Committee (Date: 05.07.2023, Decision No: 2023-KAEK-52). The study was conducted according to the Declaration of Helsinki.

The study population was defined as individuals aged 18 to 65 because elderly patients may have electromyography (EMG) anomalies and extremely old patients are likely to have concomitant disorders. The exclusion criteria are patients with systemic diseases known to cause CTS, such as diabetes mellitus (DM), hypothyroidism, rheumatoid arthritis (RA), or chronic renal failure. Patients with conditions that could mimic CTS or interfere with its evaluation, such as cervical radiculopathy, proximal median neuropathy, significant polyneuropathy, or notable orthopedic abnormalities, as well as those diagnosed with multiple sclerosis, myasthenia gravis, PD, or other movement disorders. Additionally, patients who were pregnant, undergoing hormone or corticosteroid therapy, or had a history of trauma or surgery to the hand or wrist were excluded from the study.[16]

Participants who agreed to take part in the study provided informed consent, and a sociodemographic form specifically designed for patients with ET was administered, which included details on age, sex, dominant hand, and disease duration. All patients underwent detailed neurological examination by a neurologist. Additionally, the Fahn-Tolosa-Marin Clinical Tremor Rating Scale (FTM TRS) was applied.[17]

The FTM TRS rating scale is divided into three parts (A, B, and C), and the subtotal score from each part can be summed to produce a total score or used separately in independent analyses. Part A primarily measures the severity of resting tremor. Part B focuses on action tremors of the hands or arms. Part C assesses functional disability, evaluating the severity of tremors during daily activities such as speaking, eating, personal hygiene, dressing, and working. On this scale, higher scores indicate more severe symptoms.[18]

Participants underwent a neurological motor and sensory examination of both hands. Ulnar and radial entrapment neuropathies were excluded from the study. Patients were evaluated for the presence and severity of CTS through EMG. The EMGs were conducted and interpreted by a neurologist with at least five years of experience in electrophysiology. The median, radial, and ulnar motor nerve response amplitudes and latencies were measured by the same neurologist. EMG results were interpreted according to the nerve conduction study criteria outlined in the American Association of Electrodiagnostic Medicine (AAEM) guidelines.[19]

Mild CTS was defined as the prolongation of median distal sensory conduction in the orthodromic, antidromic, or palmar pathways + a reduction in sensory action potential amplitudes below normal levels. Moderate CTS included these findings along with the prolongation of median nerve distal motor latency. Severe CTS was characterized by the absence of median nerve sensory action potentials, a significant reduction in the amplitude of the thenar M-response, delayed distal latencies, and partial denervation findings in the thenar EMG.

RESULTS

In the study, the mean age of the 50 patients with ET was 56.0 (35.0-64.0) years. The gender distribution comprised 22 (44.0%) males and 28 (56.0%) females. Regarding handedness, 38 (76.0%) were right-handed, 5 (10.0%) left-handed, and 7 (14.0%) ambidextrous.

Occupational distribution was as follows: 13 (26.0%) retired, 14 (28.0%) homemakers, 11 (22.0%) workers, 6 (12.0%) civil servants, and 6 (12.0%) students. Among the participants, 18 (36.0%) had chronic diseases. Tremor locations were reported as follows: 41 (82.0%) in both upper extremities, 3 (6.0%) in the right upper extremity, 2 (4.0%) in the left upper extremity, 1 (2.0%) in both upper extremities, head tremor, and voice, and 3 (6.0%) in both upper extremities and head tremor. The disease duration was 4.0 (2.0-10.0) years. All patients had upper extremity involvement, while none had lower extremity involvement. Head tremor was observed in 9 (18.0%) patients, voice tremor in 5 (10.0%), and a family history of tremor in 22 (44.0%). Table 1 provides descriptive statistics for the individuals included in the study.

Table 2 compares age, sex, disease duration, Part A, Part B, Part C, and total score variables based on EMG status. As a result of these comparisons, there were no statistically significant differences found between age, handedness, Part A, Part B, Part C, and total score variables across the EMG groups ($p>0.05$). However, there was a statistically significant difference between sex and disease duration in the EMG groups ($p<0.05$). This difference is attributed to the higher representation of males in the normal group and females in the moderate group. For disease duration, this significance arises from the observation that those with mild disease had a longer duration compared to those in the normal group.

Table 1. Descriptive statistics of participants included in the study

Characteristics	Patients (n=50)
Age	56.0 (35.0-64.0)
Gender	
Male	22 (44.0)
Female	28 (56.0)
Dominant hand	
Right	38 (76.0)
Left	5 (10.0)
Bilateral	7 (14.0)
Occupation	
Retiring	13 (26.0)
Homemaker	14 (28.0)
Worker	11 (22.0)
Civil servent	6 (12.0)
Student	6 (12.0)
Chronic disease	
Yes	18 (36.0)
No	32 (64.0)
Tremor location	
Both upper extremities	41 (82.0)
Right upper extremity	3 (6.0)
Left upper extremity	2 (4.0)
Both upper extremities, head and voice tremor	1 (2.0)
Both upper extremities and head tremor	3 (6.0)
Disease duration	4.0 (2.0-10.0)

Data are expressed as mean ± standard deviation, n (%) and median (25th percentile-75th percentile).

Table 2. Comparison of A, B, C, and total scores according to EMG levels

Characteristics	EMG			p
	Mild CTS (n=40)	Moderate CTS (n=5)	Normal EMG (n=55)	
Age	58.5 (32.0-64.0)	63.0 (36.0-64.0)	54.0 (38.0-65.0)	0.891
Gender				
Male	15 (37.5)[ab]	0 (0.0)[a]	29 (52.7)[b]	0.040
Female	25 (62.5)[ab]	5 (100.0)[a]	26 (47.3)[b]	
Dominant hand				
Right	31 (77.5)	4 (80)	41 (74.5)	
Left	4 (10.0)	0 (0.0)	6 (10.9)	0.985
Bilateral	5 (12.5)	1 (20.0)	8 (14.5)	
Disease duration	8.0 (3.0-10.0)[a]	4.0 (1.0-7.5)[ab]	3.0 (2.0-9.0)[b]	0.032
Part A	3.0 (2.0-4.0)	3.0 (2.0-3.5)	3.0 (2.0-4.0)	0.860
Part B	2.0 (1.0-8.0)	6.0 (2.0-8.5)	8.0 (1.0-10.0)	0.476
Part C	2.0 (1.3-4.0)	2.0 (0.0-3.5)	2.0 (0.0-5.0)	0.388
Total score	8.0 (5.3-15.0)	8.0 (8.0-13.0)	11.0 (6.0-19.0)	0.664

Data are expressed as median (25th percentile-75th percentile) and n (%), Similar characters on the same line indicate group similarity, whereas dissimilar characters indicate group differences.

Table 3. Relationship between EMG status and occupation in women

Characteristics	EMG			p
	Mild CTS (n=25)	Moderate CTS (n=5)	Normal EMG (n=26)	
Occupation				
Housewife	10 (40.0)	2 (40.0)	16 (61.5)	0.282
Others	15 (60.0)	3 (60.0)	10 (38.5)	

Data are expressed as n (%), EMG: Electromyography, CTS: Carpal tunnel syndrome

Figure 1. Relationship between median sensory and motor nerve amplitude and velocity measurements and Parts A, B, C, and total score.

Table 4. EMG distribution of participants for right and left sides in the study

Characteristics	Patients (*n*=50)
EMG (Right hands)	
Mild CTS	20(40.0)
Moderate CTS	2(4.0)
Normal	28(56.0)
EMG (Left)	
Mild CTS	20(40.0)
Moderate CTS	3(6.0)
Normal	27(54.0)

Data are expressed as n (%), EMG: Electromyography, CTS: Carpal tunnel syndrome

Table 3 evaluates the relationship between EMG status and occupation among women, revealing no statistically significant difference (p>0.05).

Table 4 presents the EMG results of the patients in the study, indicating that among the 22 patients (44%) diagnosed with CTS, 22 had bilateral involvement, while 1 patient (2%) had CTS in the left hand. According to the EMG results, 27 patients (54%) were assessed as normal. The distribution of EMG results for the right hand was as follows: mild in 20 (40.0%), moderate in 2 (4.0%), and normal in 28 (56.0%). The distribution for the left hand was mild in 20 (40.0%), moderate in 3 (6.0%), and normal in 27 (54.0%).

Figure 1 examines the relationship between FTM TRS Part A, Part B, Part C, and total score with the measurement levels of sensory conduction velocity and amplitude for the right and left hands, revealing no statistically significant relationship (p>0.05).

Statistical Analysis

The normality of the data distribution was assessed using histograms, Q-Q plots, and the Shapiro-Wilk test. Chi-square analysis was used for comparisons between categorical variables. For comparisons of continuous variables across groups, the Kruskal-Wallis test was applied. The Bonferroni test was utilized for multiple comparisons. The relationships between continuous variables were determined using Pearson correlation analysis. Data analysis was performed using IBM SPSS Statistics version 22. A significance level of p<0.05 was considered statistically significant.

DISCUSSION

One of the most impressive findings of our study was that CTS was present at a high rate of 46% in ET patients, even after the most frequent comorbidities were eliminated. Other notable findings were that female gender and extended disease duration were substantially linked with CTS in ET patients.

CTS is multifactorial, with obesity, DM, hypothyroidism, and RA commonly associated with CTS.[5,20] Although 37% of patients in our study reported chronic diseases, these conditions are not significant risk factors for CTS. To determine the specific impact of ET, all associated diseases that could potentially act as risk factors were excluded from the study.

The global prevalence of CTS has been reported to range from 2.7% to 5.8%.[5,21,22] Among the most commonly associated conditions that increase the risk of CTS, a history of previous wrist fracture is identified as the most significant risk factor, demonstrating a 2.29-fold increase in risk. Other associated conditions that increase the risk include RA (2.23-fold), obesity (2.06-fold), osteoarthritis of the wrist and carpus (1.89-fold), insulin use (1.52-fold), and diabetes (1.51-fold). Smoking, hormone replacement therapy, the combined oral contraceptive pill, and oral corticosteroids were not found to be associated with CTS.[5]

CTS has been reported to occur in up to 15% of diabetic patients.[22] Similarly, a relationship has been noted between CTS and hypothyroidism, with evidence suggesting that nearly 29% of hypothyroid patients might have signs of CTS on nerve conduction studies.[23] Another study reported this prevalence as 32.5%.[24] In our study, however, CTS was observed in 46% of patients with ET, indicating that this rate is higher than that reported for the associated conditions of DM and hypothyroidism.

The incidence of CTS is shown to increase after the age of 55.[25] In another study, it was found that CTS increases with age, reaching 22.2% in individuals over 55 years, compared to 6 % among participants aged 25 to 34.[26] The higher prevalence in older patients is thought to reflect different pathophysiological conditions.[27] Contrary to these studies, our research did not identify an age-related increase between ET and CTS. It is known that the prevalence of ET increases with age, particularly in older individuals, and it appears that a similar trend may occur with CTS.[25,28] The estimated prevalence of ET is 0.9%, which rises to 4.6% in individuals aged ≥65 years.[8] In contrast, our study did not find an age-related increase in CTS among patients with ET. Among the limited studies in the literature examining the relationship between ET and CTS, Eliacik et al.[12] a CTS prevalence of 16% in patients with ET, noting that the study included participants under the age of 45 and a healthy control group, which may not reflect the typical age of occurrence for both ET and CTS, representing a limitation of the study. In our study, however, CTS was observed in 46% of patients. The average age of 54 in our patient population may explain the difference in prevalence compared to Eliacik's study.[12]

Moreover, female sex and age have been associated with CTS.[20] The female-to-male ratio has been reported to vary between 2 and 7 in different studies.[20,25,29] In a study examining housewives who underwent surgery for CTS, a 3.6-fold higher incidence of CTS was reported.[30] Another study found that, when considering other risk factors, 47.5% of housewives were affected by CTS.[20] The higher prevalence among women and housewives has been attributed to their involvement in high-risk occupations for CTS, including household chores.[20,29] In our study, no significant difference was found between housewives and other professions regarding the incidence of CTS in patients with ET, suggesting that the increase in CTS observed in women may be related to essential tremor.

Lam et al.[25] found that patients with CTS are twice as likely to be overweight (BMI>25) compared to the general population, and that female patients are twice as likely to be obese (BMI>30) compared to their counterparts in the general population. In another study, individuals classified as obese (BMI>29) were found to be 2.5 times more likely to develop CTS than slender individuals (BMI<20).[20] In our study, the average BMI was found to be 27.95. The high prevalence of CTS in our study may be particularly vulnerable to confounding factors such as BMI. However, it is clear that the 46% prevalence of CTS in patients with ET cannot be solely attributed to elevated BMI.

ET is a deceptively simple clinical syndrome associated with a complex network of clinical, pathological, and genetic phenomena.[31] Classic ET is a clinical syndrome characterized by action tremor, occurring in the upper extremities in the absence of other neurological signs in 95% of cases. The tremor usually begins in the upper extremities and is symmetric in approximately 80% of patients.[31] In our study, 100% of patients with ET exhibited tremor in the upper extremities, with only 66% presenting bilateral upper extremity tremor. No association was found between the severity of tremor and CTS.

PD, a common movement disorder, is characterized by bradykinesia, rigidity, postural instability, and tremor. The characteristic tremor in PD is unilateral and at rest, disappearing with voluntary movement.[32] Due to the presence of unilateral tremor, many researchers have investigated the association between PD and CTS.[4,6] Han et al.[4] demonstrated in their study that CTS developed in the hand without tremor, indicating that tremor in the dominant hand is not associated with the development of CTS. They suggested that tremors in PD involve the fingers more than the wrist.

Sonographic studies have shown median nerve enlargement in both ET and PD.[10,11,13] It has been reported that repetitive movements in patients with ET lead to median nerve enlargement, which may contribute to the development of CTS.[13] Although this study demonstrated a relationship between the severity of tremor and median nerve enlargement as assessed by the Fahn-Tolosa-Marin Tremor Rating Scale (FTM-TRS), our study did not find an association between tremor severity and CTS when evaluated by EMG.

The cause of the relationship between ET and CTS has not yet been established. It is known that ET is associated with structural changes in the cerebellum, and cerebellar plasticity is observed in its pathophysiology.[12,33] Interestingly, changes in cerebellar activity have been demonstrated in CTS.[34] Yu et al.[35] showed that more than 70% of patients with median and radial nerve involvement benefited therapeutically for at least 60 minutes after the cessation of transcutaneous afferent patterned stimulation.

CONCLUSION

A high prevalence of CTS has been observed in patients with ET, suggesting that ET itself may be a risk factor for CTS, independent of other associated diseases and conditions previously identified. Additionally, a positive correlation was found between CTS in ET patients, long disease duration, and female gender. Considering the significant impact of both ET and CTS on individuals quality of life, early diagnosis and treatment should be prioritized to improve the long-term management of CTS in patients with ET.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethical approval for this study was obtained from the Kastamonu University Clinical Researches Ethics Committee (Date: 05.07.2023, Decision No: 2023-KAEK-52).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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